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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**APPLICATION FOR LETTERS PATENT**

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**Integrated Circuit Package Separators, And  
Methods Of Forming Integrated Circuit Packages**

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ATTORNEY'S DOCKET NO. MI22-975

# Integrated Circuit Package Separators, And Methods Of Forming Integrated Circuit Packages

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## TECHNICAL FIELD

The invention pertains to methods of forming integrated circuit packages, as well as to devices for separating integrated circuit packages.

## BACKGROUND OF THE INVENTION

Circuit constructions having integrated circuit (IC) chips bonded to circuit boards (such as SIMMs and DIMMs) can be fabricated by joining IC chips on a single large circuit board comprising a plurality of the constructions. The circuit board can be subsequently cut to separate discrete constructions from one another. The discrete constructions are referred to herein as integrated circuit packages. The smaller the individual circuit packages, the more likely it is for industry processing to utilize the above-described method of forming the packages on a single large board and subsequently cutting individual packages from the board.

An exemplary prior art process of separating integrated circuit packages is described with reference to Fig. 1. Fig. 1 illustrates a board assembly 10 having a plurality of IC chips 12 (only some of which are labeled) bonded thereto. Chips 12 are aligned into individual IC package configurations 14 (only some of which are labeled) to form a repeating pattern of integrated circuit packages 14 across the board.

1 assembly 10. Dashed lines 16 are shown to illustrate the boundaries  
2 between individual IC packages 14. In the shown exemplary embodiment,  
3 assembly 10 comprises three separate circuit boards 11, 13 and 15. The  
4 number and size of individual circuit boards can vary depending on the  
5 number and size of IC packages that are ultimately to be formed.

6 Each of boards 11, 13 and 15 comprises a pair of lateral waste  
7 sections 21, 23 and 25, respectively. The lateral waste sections 21, 23  
8 and 25 are separated from the remainder of boards 11, 13 and 15,  
9 respectively, by imaginary dashed lines 20, 22 and 24. In further  
10 processing, the individual IC packages 14 are separated from one another  
11 by cutting through boards 11, 13 and 15 along the regions illustrated by  
12 dashed lines 16. During the cutting to separate IC packages 14 from  
13 one another, boards 11, 13 and 15 are also cut along regions illustrated  
14 by dashed lines 20, 22 and 24 to remove waste portions 21, 23 and 25  
15 from the lateral sides of the boards, and accordingly from lateral edges  
16 of the ultimately formed IC packages.

17 Orifices 19 (only some of which are labeled) are provided  
18 throughout circuit boards 11, 13 and 15. Specifically, pairs of orifices 19  
19 are provided in each IC package 14, and at least two orifices 19 are  
20 provided in each of waste portions 21, 23 and 25.

21 Fig. 1 further illustrates an IC package separator 40 comprising a  
22 cutting mechanism 42 (shown schematically as a cutting wheel, although  
23 other cutting mechanisms, such as, for example, router bits or linear

1 blades, are known to persons of ordinary skill in the art), a retaining  
2 table 44, and a control mechanism 45 configured to control orientation  
3 of cutting wheel 42 relative to table 44. Retaining table 44 can  
4 comprise, for example, an x-y table (i.e., a table horizontally adjustable  
5 in x and y directions; an "X", "Y" and "Z" axis system is illustrate in  
6 a lower corner of Fig. 1). Control mechanism 45 can control the x  
7 and y orientation of table 44 and the z (i.e., vertical) orientation of  
8 cutting mechanism 42 to precisely cut a board retained on table 44.  
9 Table 44, cutting mechanism 42, and control mechanism 45 can be  
10 comprised by commercially available cutting systems, such as, for example,  
11 Advanced Technology Incorporated's CM101 single spindle router (or,  
12 more generally, a circuit board depanelization router).

13 Fig. 1 also illustrates that table 44 comprises an upper  
14 platform 46. A subplate 48 is provided over platform 46, and a stripper  
15 plate 50 is provided over subplate 48. Subplate 48 comprises a plurality  
16 of upwardly extending pins 60 (only some of which are labeled), and  
17 stripper plate 50 comprises a number of orifices 62 configured to slide  
18 over pins 60. Subplate 48 is retained on table 44 by downwardly  
19 extending pins (not shown) which are aligned with and precisely received  
20 within orifices (not shown) extending within platform 46 of table 44.

21 Orifices 19 of boards 11, 13 and 15 align with pins 60. In  
22 operation, boards 11, 13 and 15 are slid over pins 60 until the pins  
23 protrude through orifices 19. Typically, orifices 19 are only about

0.003 inches wider than pins 60 to insure tight alignment of boards 11, 13 and 15 with subplate 48. After boards 11, 13 and 15 are retained on table 44 by pins 60, cutting mechanism 42 is utilized to cut along the regions illustrated by dashed lines 16, 20, 22 and 24. Such cutting separates discrete integrated circuit packages 14 from one another, as well as from waste regions 21, 23 and 25. The separated circuit packages are retained on table 44 by pins 60 extending through the packages. Specifically, each of individual packages 14 comprises a pair of orifices 19 and is thereby retained on table 44 by a pair of pins 60.

After the IC packages are separated from one another, stripper plate 50 is manually lifted off of subplate 42 to lift the IC packages 14 from pins 60. Once stripper plate 50 is lifted off from pins 60, the individual IC packages can be separated from stripper plate 50. An exemplary method of removing the IC packages from stripper plate 50 is to tilt plate 50 and allow the packages to slide off plate 50. After the packages 14 are removed, plate 50 can be returned to over 48 and used again for separating IC packages.

Difficulties can occur in utilizing the assembly of Fig. 1 for separating IC packages. For instance, separated IC packages can be broken as stripper plate 50 is lifted from subplate 48. It would be desirable to reduce or eliminate such problems.

1            SUMMARY OF THE INVENTION

2            In one aspect, the invention encompasses a method of forming  
3            integrated circuit packages. A base having a plurality of pins extending  
4            upwardly therefrom is provided. A support is provided over the base.  
5            The support has an upper surface and a plurality of holes extending  
6            therethrough. The pins extend through the holes and upwardly beyond  
7            the upper surface of the support. An actuator is provided beneath the  
8            support. A board having a plurality of integrated circuits bonded thereto  
9            is provided. The integrated circuits form a repeating pattern of  
10            integrated circuit packages across the board, and the board has a  
11            plurality of holes extending through it. The board is placed over the  
12            support upper surface with the pins extending into the holes in the  
13            board. While the board is over the support upper surface, it is cut to  
14            separate the integrated circuit packages from one another. After the  
15            cutting, the support is vertically displaced by the actuator to lift the  
16            support off the pins.

17            In another aspect, the invention encompasses an integrated circuit  
18            package separator for separating integrated circuit packages from a board.  
19            The board comprises a plurality of integrated circuits bonded thereto,  
20            and has a plurality of holes extending within it. The separator includes  
21            a base having a plurality of pins extending upwardly therefrom and a  
22            support over the base. The support has an upper surface, a plurality  
23            of holes extending therethrough, and a pair of opposing ends. The pins

1 extend through the holes in the support and upwardly beyond the upper  
2 surface of the support. The support and pins are configured such that  
3 the pins extend into the holes in the board when the board is placed  
4 over the support upper planar surface. The separator further includes  
5 a pair of actuators beneath the support and configured to vertically  
6 displace the support and lift the support off the pins. Additionally, the  
7 separator includes a cutting mechanism configured to cut the board while  
8 the board is over the support upper planar surface and thereby separate  
9 the integrated circuit packages from one another.

10

11 **BRIEF DESCRIPTION OF THE DRAWINGS**

12 Preferred embodiments of the invention are described below with  
13 reference to the following accompanying drawings.

14 Fig. 1 is a diagrammatic, perspective, exploded view of a prior art  
15 IC package separator and circuit board assembly.

16 Fig. 2 is a diagrammatic top view of an IC package separator of  
17 the present invention.

18 Fig. 3 is a diagrammatic, perspective, exploded view of an IC  
19 package separator of the present invention with a stripper plate of the  
20 present invention and a circuit board.

21 Fig. 4 is a view of the Fig. 3 assembly with the circuit board  
22 retained on the IC separator.

Fig. 5 is a view of the Fig. 4 assembly after the retained circuit board is cut to separate individual IC packages from one another.

Fig. 6 is a view of the Fig. 5 assembly after a stripper plate is lifted to release separated IC packages from retaining pins.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

An IC package separator of the present invention and a method of operation of such separator are described below with reference to Figs. 2-6. In referring to Figs. 2-6, similar numbering to that utilized above in describing prior art Fig. 1 will be used, with differences indicated by the suffix "a" or by different numerals.

Referring to Fig. 2, a separator 100 of the present invention is shown in top view. Separator 100 comprises a table 44a and a subplate 48a provided over table 44a. Table 44a can comprise, for example, an x-y table similar to the table 44 described above with reference to Fig. 1. Subplate 48a, like the above-described substrate 48 of Fig. 1, can be joined to table 44a through a plurality of downwardly extending pins (not shown), and comprises a plurality of upwardly extending pins 60 (only some of which are labeled) configured to retain a circuit board assembly (not shown).

1 Subplate 48a differs from subplate 48 of Fig. 1 in that  
2 subplate 48a comprises notches 102 at its ends. Notches 102 are  
3 provided to allow room for a pair of forcer plates 104 and 106 to move  
4 vertically (in and out of the page of Fig. 2) relative to table 48a.  
5 Forcer plates 104 and 106 comprise upwardly extending pins 108  
6 and 110, respectively. Base plate 48a comprises an upper planar  
7 surface 115, and forcer plates 104 and 106 comprise upper planar  
8 surfaces 117 and 119, respectively. Upper planar surfaces 115, 117  
9 and 119 ultimately support a circuit board assembly (not shown in  
10 Fig. 2). Planar surfaces 115, 117 and 119 are preferably substantially  
11 coplanar with one another to avoid distorting (e.g., bending) a supported  
12 circuit board assembly.

13 Forcer plates 104 and 106 are connected to actuators 112 and 114,  
14 respectively, configured to vertically displace forcer plates 104 and 106.  
15 In the exemplary shown embodiment, forcer plates 104 and 106 are  
16 connected to the actuators with screws 116. It is to be understood,  
17 however, that other mechanisms could be utilized for joining forcer  
18 plates 104 and 106 to actuators 112 and 114, including, for example,  
19 welding.

20 Actuators 112 and 114 are pneumatic (preferably air-powered) and  
21 connected to a gas source 120. An advantage of utilizing air powered  
22 actuators is that most wafer fabrication plants have a source of clean dry  
23 air available. Accordingly, it is relatively convenient to couple air

1        powered actuators 112 and 114 into existing fabrication plants by simply  
2        connecting them to existing air lines. However, it is to be understood  
3        that the actuators can be powered by other sources besides air, including,  
4        for example, other fluids, such as liquids, as well as non-pneumatic and  
5        non-hydraulic sources, such as, for example, electricity.

6        Separator apparatus 100 comprises a cutting assembly (not shown  
7        in Fig. 2) and a controller (not shown in Fig. 2), analogous to the  
8        cutting assembly 42 and controller 45 of Fig. 1.

9        Referring to Fig. 3, IC circuit package separator 100 is shown in  
10       exploded view with a circuit board assembly 10 identical to the assembly  
11       described above with reference to Fig. 1.

12       A stripper plate 50a is provided between subplate 48a and circuit  
13       board assembly 10. Stripper plate 50a is similar to the stripper plate 50  
14       of Fig. 1 in that plate 50a comprises a plurality of orifices 62 configured  
15       for receipt of pins 60. However, stripper plate 50a differs from plate 50  
16       of Fig. 1 in that plate 50a also comprises orifices 122 configured for  
17       receipt of upwardly extending pins 108 and 110 of forcer plates 104  
18       and 106. Pins 108 and 110 are preferably tapered pins, such as can be  
19       obtained from McMaster-Carr. Exemplary pins have a dimension  
20       of 0.248 inches at base, 0.2324 inches at top, and a length of  
21       0.75 inches. The taper of the pins can assist in aligning support 50a  
22       over the pins during placement of support 50a onto base 48a.

1 Stripper plate 50a further differs from plate 50 of Fig. 1 in that  
2 plate 50a is configured for receipt of a series of panels 132, 134  
3 and 136. Stripper plate 50a can comprise, for example, static-reduced  
4 plastic having a thickness of greater than 3/16 inches, and panels 132,  
5 134 and 136 can comprise, for example, aluminum. In the shown  
6 embodiment, panels 132, 134 and 136 are held to stripper plate 50a by  
7 a plurality of screws 138 (only some of which are labeled). It will be  
8 recognized, however, that other mechanisms can be utilized for holding  
9 panels 132, 134 and 136 to stripper plate 50a, including riveting.  
10 Alternatively, panels 132, 134 and 136 can be molded as part of stripper  
11 plate 50a.

12 Panels 132, 134 and 136 comprise ribs 140, 142 and 144,  
13 respectively (only some of which are labeled). Ribs 140, 142 and 144  
14 can assist in supporting board assembly 10. Specifically, IC chips 12 are  
15 frequently provided on both an upper surface of circuit board  
16 assembly 10, and a bottom surface (not shown). Ribs 140, 142 and 144  
17 (also referred to as blocks) have upper surfaces 141, 143 and 145,  
18 respectively, which contact the bottom surfaces of circuit boards 11, 13  
19 and 15 at locations between the IC chips 12 on the bottom of the  
20 board. Preferably, such upper surfaces are provided at a height  
21 approximately equal to a thickness of integrated circuit chip  
22 components 12. Accordingly, when boards 11, 13 and 15 are rested on  
23 panels 132, 134 and 136, respectively, the boards rest on the upper

1 surfaces of blocks 140, 142 and 144 while leaving integrated circuit chip  
2 components on the underside of boards 11, 13 and 15 extending between  
3 block upper surfaces 141, 143 and 145 and panels 132, 134 and 136.

4 An exemplary block height (or thickness) of blocks 140, 142 and 144 for  
5 a DRAM having IC chips 12 with a TSOP dimensional package is 0.040  
6 inches  $\pm 0.005$  inches. As another example, if IC chips 12 have a SOJ  
7 dimensional package, the block height is preferably 0.140 inches  $\pm 0.005$   
8 inches.

9 Blocks 140, 142 and 144 can be formed as one piece with panels  
10 132, 134 and 136. Alternatively, blocks 140, 142 and 144 can be formed  
11 as discrete pieces from panels 132, 134 and 136 that are subsequently  
12 fastened to the panels.

13 In the shown embodiment, blocks 140, 142 and 144 are provided  
14 in a one-to-one correspondence with integrated chip packages 14. Also,  
15 in the shown exemplary embodiment each of panels 132, 134 and 136 is  
16 identical to one another, and in a one-to-one correspondence with  
17 individual boards 11, 13 and 15. It is to be understood, however, that  
18 the invention encompasses other embodiments (not shown) wherein the  
19 blocks are not provided in a one-to-one correspondence with  
20 packages 14, wherein the panels are not identical to one another, and  
21 wherein the panels are not in a one-to-one correspondence with the  
22 individual boards.

23

1 Pins 60 extend upwardly beyond upper surfaces 141, 143 and 145  
2 of blocks 140, 142 and 144, and are configured to retain circuit board  
3 assembly 10 over stripper panel 50a. In the shown embodiment, pins 60  
4 do not extend through panels 132, 134 and 136. However, it is to be  
5 understood that the invention encompasses other embodiments wherein  
6 pins 60 do extend through such panels.

7 Fig. 3 shows a side perspective view of actuator 112. In such  
8 view it can be seen that several ports 150, 152, 153, 154, 155 and 156  
9 are provided between actuator 112 and gas source 120. Valves (not  
10 shown) are provided between source 120 and one or more of ports 150,  
11 152, 153, 154, 155 and 156. Such valves enable fluid to be selectively  
12 flowed from source 120 into one or more of ports 150, 152, 153, 154,  
13 155 and 156 to selectively control raising and lowering of forcer  
14 plate 104 with actuator 112. For instance, flow of gas into port 152 can  
15 force a pneumatic cylinder to lift forcer plate 104, and flow of gas into  
16 port 150 can force the pneumatic cylinder to lower forcer plate 104.

17 Ports 154 and 156 are connected to release valves 163 and 165,  
18 respectively, which enable a pressure on at least one side of the  
19 pneumatic cylinder of actuator 112 to be maintained at ambient pressure  
20 (generally, about 1 atmosphere). Specifically, release valves 163 and 165  
21 comprise outlet ports 157 and 159, respectively, which vent to a  
22 surrounding environment. Persons of ordinary skill in the art will  
23 recognize that one or more of ports 150, 157 and 159 are utilized as gas

1 outlet ports during lifting of forcer plate 104, and port 152 comprises  
2 a gas inlet port during such lifting. In preferred embodiments of the  
3 present invention, the release valves are associated with an outlet side  
4 of actuator 112 to enable equilibration of a pressure at such outlet side  
5 to ambient prior to (and/or during) lifting of forcer plate 104.  
6 Specifically, the release valves enable gas to be drained from outlet lines  
7 (more specifically, the gas is drained through ports 157 and 159 which  
8 are open to ambient conditions) prior to, and/or during, lifting with the  
9 actuator. Actuator 114 (Fig. 2) is preferably identical to actuator 112  
10 and connected to an identical valve and port assembly as that shown  
11 connected to actuator 112. Accordingly, actuator 114 is also connected  
12 with release valves configured to equilibrate a back-pressure of the  
13 actuator to ambient prior to, and/or during, lifting of stripper panel 50a.  
14 The equilibration of pressure at the outlet ends of both of actuators 112  
15 and 114 to ambient during a lifting operation can enable both actuators  
16 to have an identical back-pressure during the lifting operation. This can  
17 facilitate having both actuators lift simultaneously and in unison. Such  
18 simultaneous lifting can avoid distortion (such as, for example, bending)  
19 of circuit board assembly 10 during the lifting.

20 Stripper plate 50a has an upper planar surface 160 and a pair of  
21 opposing ends 162 and 164. Opposing ends 162 and 164 overlie forcer  
22 plates 104 and 106, respectively. In operation, actuators 112 and 114  
23 are utilized to lift opposing ends 162 and 164 simultaneously and in

1       unison. Such can be accomplished by, for example, maintaining  
2       approximately equal gas pressure at both of actuators 112 and 114 during  
3       lifting, and is found to reduce breakage of integrated circuit packages  
4       relative to prior art methods. The term "approximately" in the previous  
5       sentence is utilized to indicate the gas pressure at both actuators is  
6       equal within operational parameters.

7       A method of operation of separator 100 is described with reference  
8       to Figs. 4-6. In referring to Figs. 4-6, subplate 48a is referred to as a  
9       base, and stripper plate 50a is referred to as a support. Referring first  
10      to Fig. 4, circuit board assembly 10 is shown retained on support 50a.  
11      Specifically, circuit board assembly 10 is placed over support upper  
12      surface 160 with pins 60 extending through orifices 19 of the circuit  
13      boards 11, 13 and 15. Pins 60 and board assembly 10 are aligned such  
14      that each of the integrated circuit packages 14 is retained to the  
15      support 50a by at least one pin, and, in the shown embodiment, is  
16      retained by 2 pins. In the Fig. 4 processing step, actuators 112 and 114  
17      (Fig. 2) are in a lowered position.

18      Referring to Fig. 5, the individual integrated circuit packages 14  
19      are separated from one another by cutting through boards 11, 13 and 15.

20      Referring to Fig. 6, actuators 112 and 114 (Fig. 2) are utilized to  
21      vertically displace support 50a from base 48a. Preferably, such vertical  
22      displacement comprises lifting both of ends 162 and 164 of support 50a  
23      substantially simultaneously and substantially in unison with one another.

1 (As used in the preceding sentence, the term "substantially" indicates  
2 that the lifting of both ends is simultaneous and in unison within  
3 operational parameters.) In exemplary applications the upper surface 160  
4 of support 50a is level prior to the lifting and remains level during the  
5 lifting. The lifting of support 50a releases separated circuit packages 14  
6 from pins 60. After such release, support 50a can be, for example,  
7 manually lifted from pins 108 and 110, and the separated packages  
8 removed from support 50a.

9 In compliance with the statute, the invention has been described  
10 in language more or less specific as to structural and methodical  
11 features. It is to be understood, however, that the invention is not  
12 limited to the specific features shown and described, since the means  
13 herein disclosed comprise preferred forms of putting the invention into  
14 effect. The invention is, therefore, claimed in any of its forms or  
15 modifications within the proper scope of the appended claims  
16 appropriately interpreted in accordance with the doctrine of equivalents.

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